



The National Solar Radiation Database (NSRDB)

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Sensing, Measurement, and Forecasting

Provide high-quality meteorological and power data for energy yield assessment, resource characterization, and grid integration

Measurements



The right observations of wind and solar resources

Modeling



Targeted predictions of resources and plant performance

Standards



Raising everyone to the same level and enabling dialog

Application of Solar Resource Information

Support the U.S. Department of Energy (DOE) SunShot goal of reducing solar deployment and financing costs through improving accuracy in solar resource modeling.

Concept

Policy Decisions
Site/Technology Selection

Increasing

Feasibility

Investor Commitment
Project Approvals

Spatial & Temporal

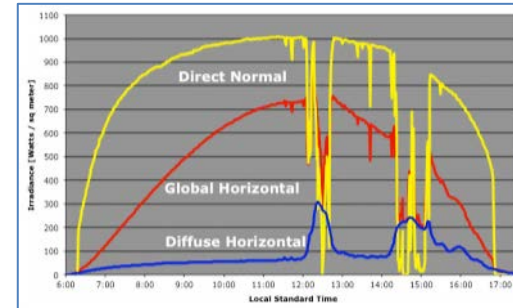
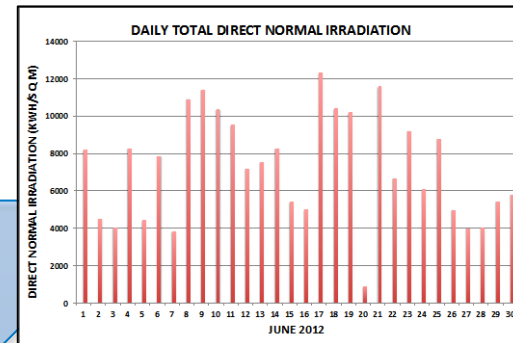
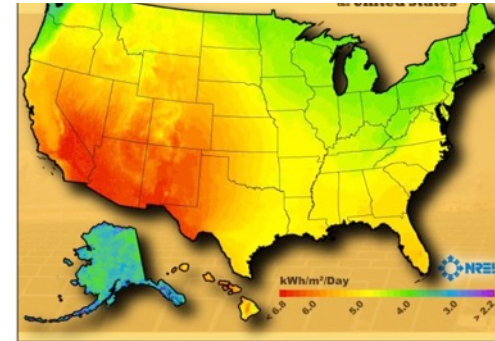
Due Diligence

Engineering Design
System Integration

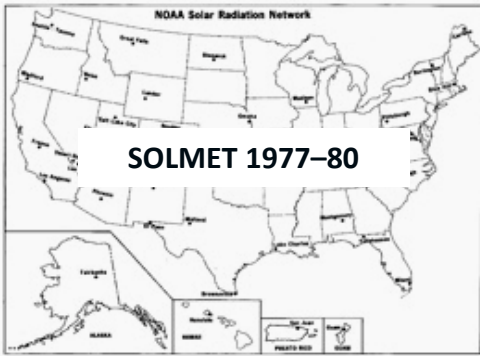
Resolution

Operations

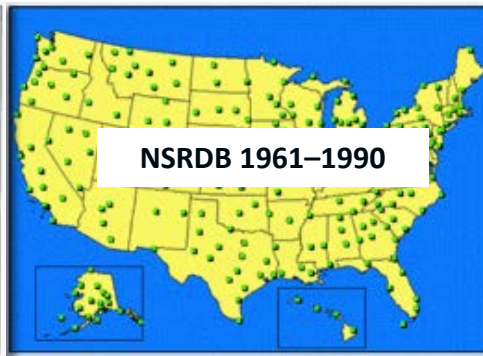
System Tests
Operation & Maintenance
Energy Systems Integration



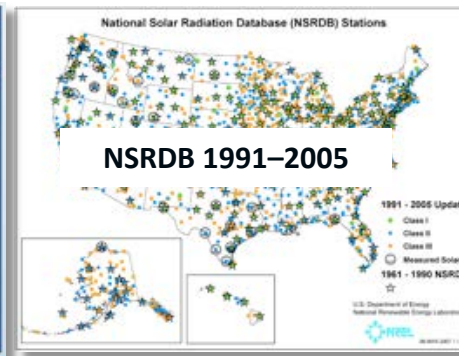
Evolution of the National Solar Radiation Database



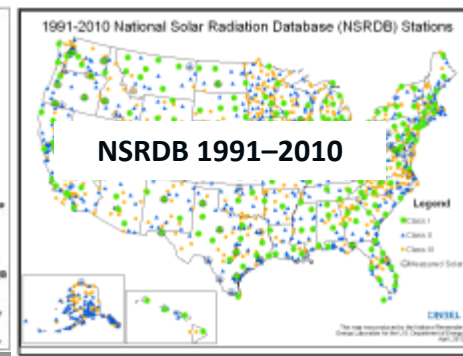
248 weather stations with 26 **Solar measurement** stations [ERDA, NOAA, 1979]



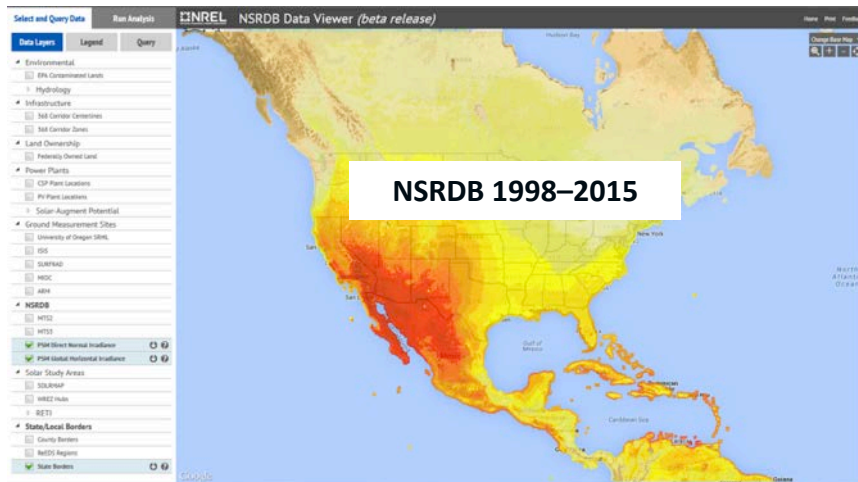
239 **modeled** stations with 56 partial measurement stations [DOE, NOAA, 1994]



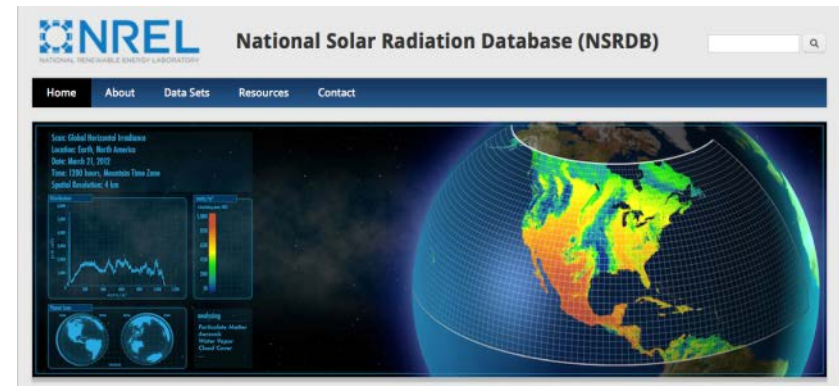
1,454 **modeled** locations [DOE, SUNY-A, NOAA, 2007]



1,454 **modeled** locations [DOE, CPR, 2012]



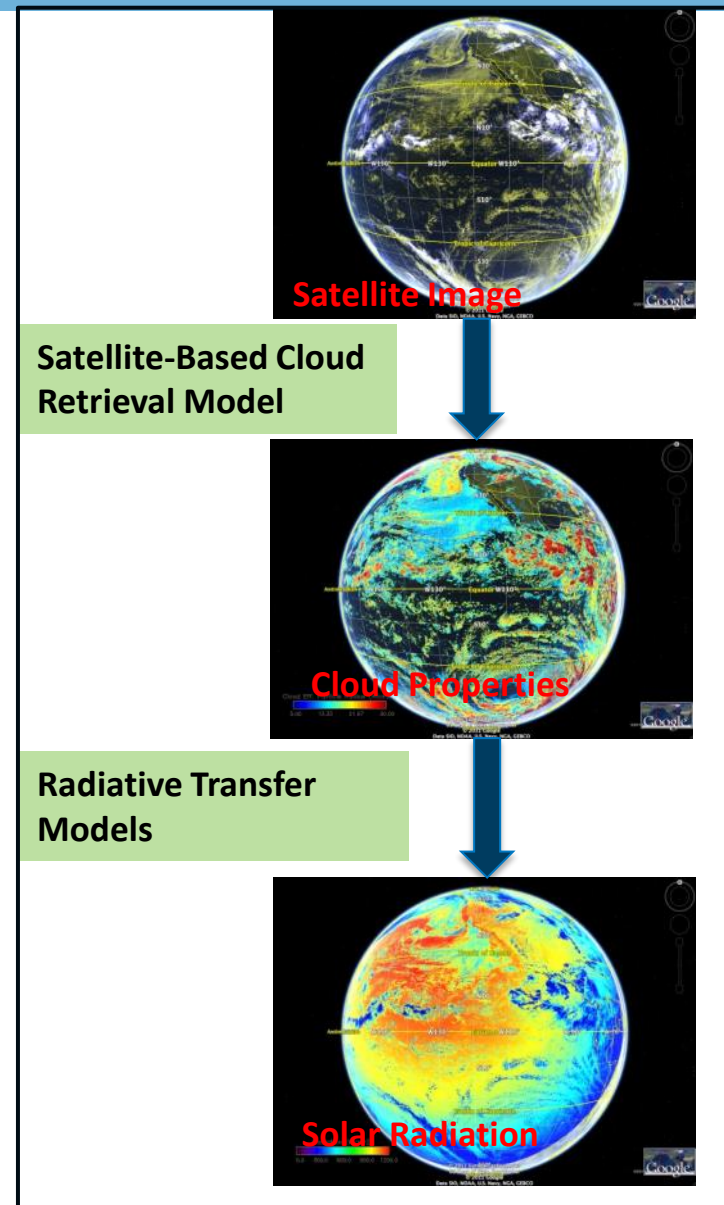
Satellite-based, gridded, 4 km x 4 km, half-hourly [DOE, NOAA, UW, SCS 2016]



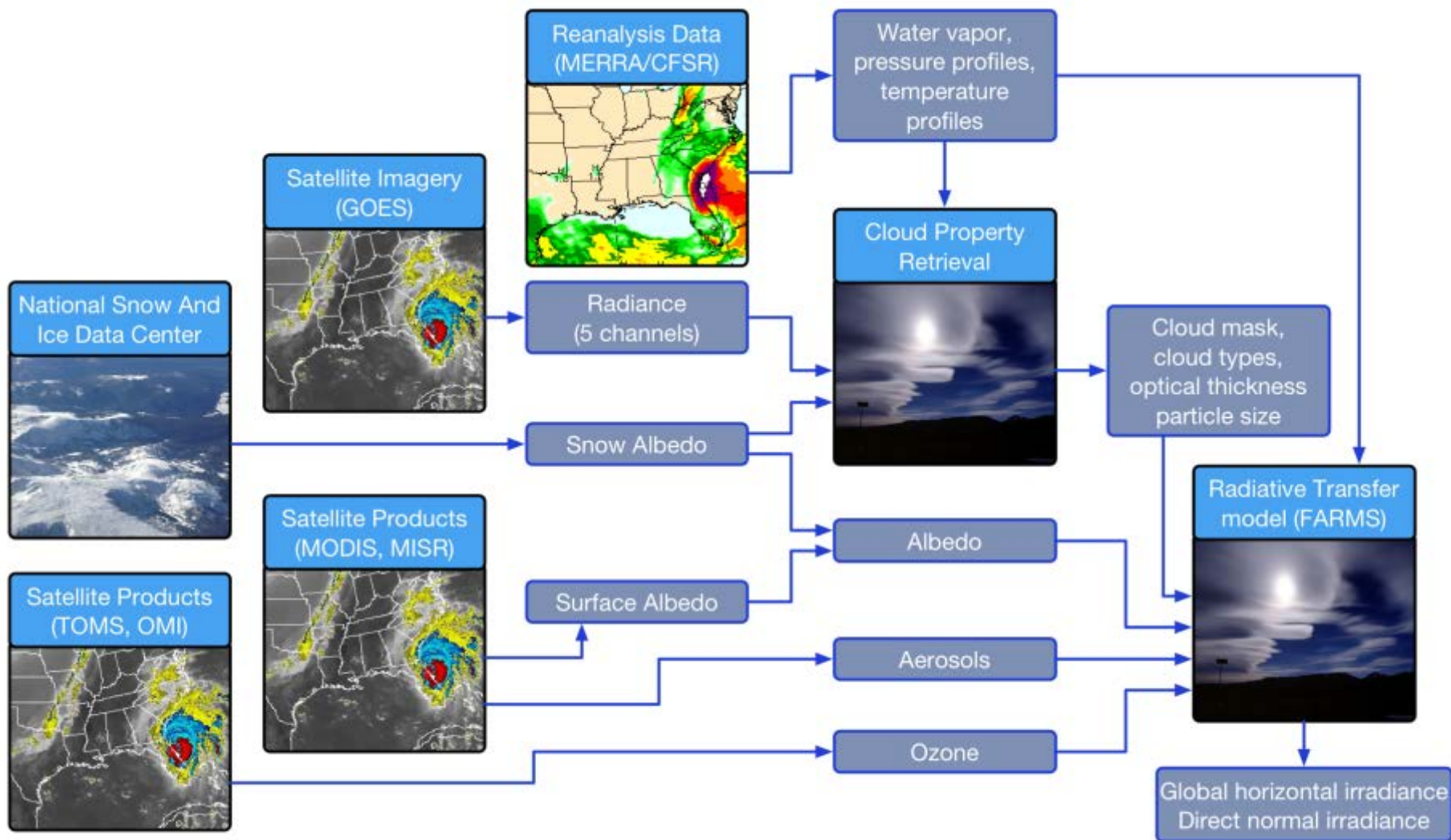
<http://nsrdb.nrel.gov>

How Do Satellites Model Surface Radiation?

- **Empirical approach (standard traditional approach by industry):**
 - Build model relating satellite measurements and ground observations (cloud index and clearness index).
 - Use those models to obtain solar radiation at the surface from satellite measurements.
- **Physical approach (the new approach):**
 - Retrieve cloud and aerosol information from satellites.
 - Use the information in a radiative transfer model.



Physical Solar Model (PSM) Framework



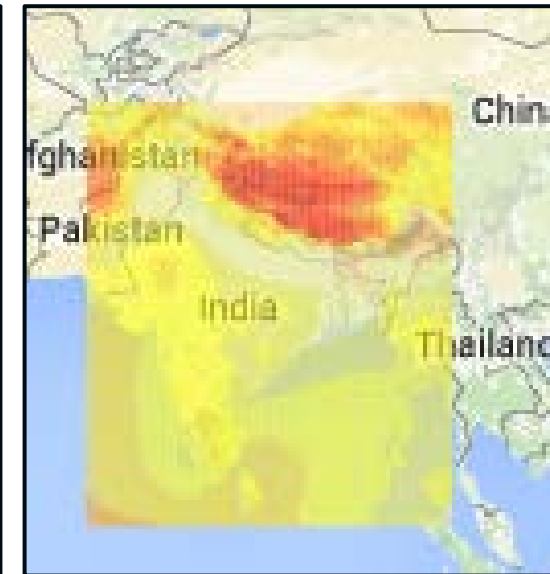
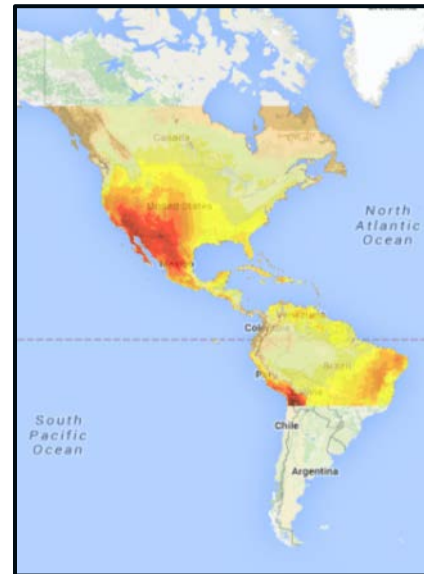
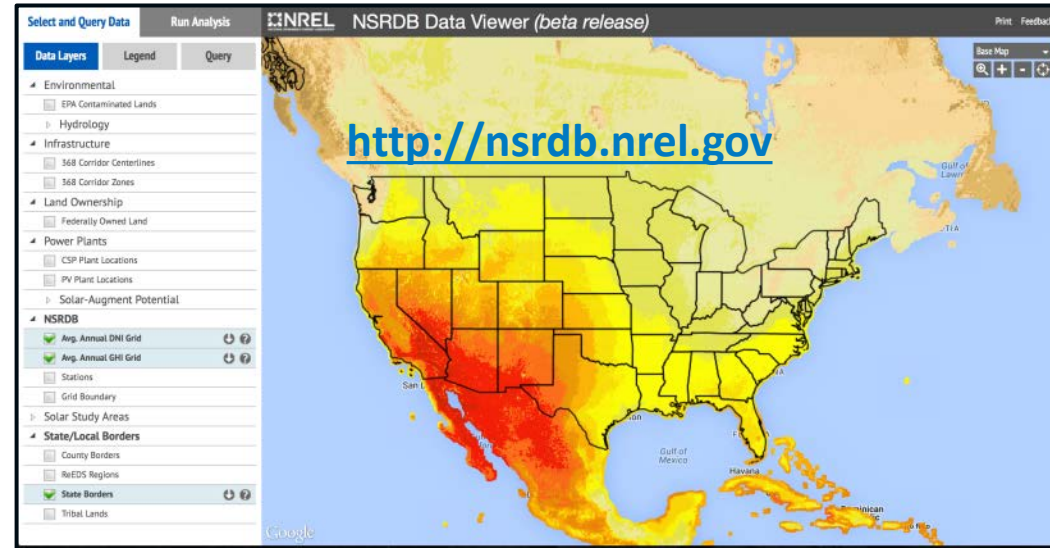
Accessing the NSRDB Data: What's Available

USA and North and South America:

- Current product (4-km, half-hourly) available from 1998–2015 (Model V2)
- Typical meteorological year (TMY) product is also available.
- Multiple summary products are available with current data sets.

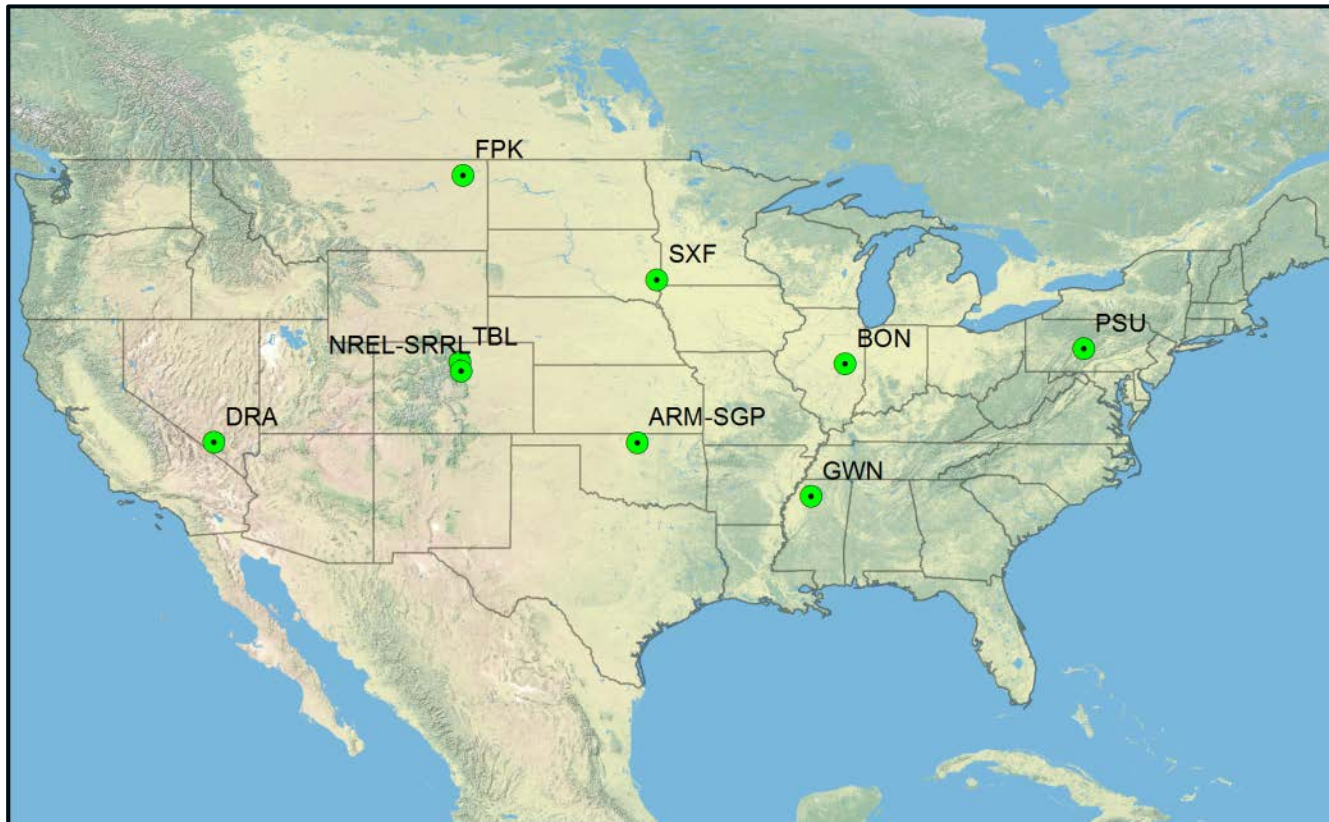
India and South East Asia:

- Data available from 2000–2014.
- TMY is also available.

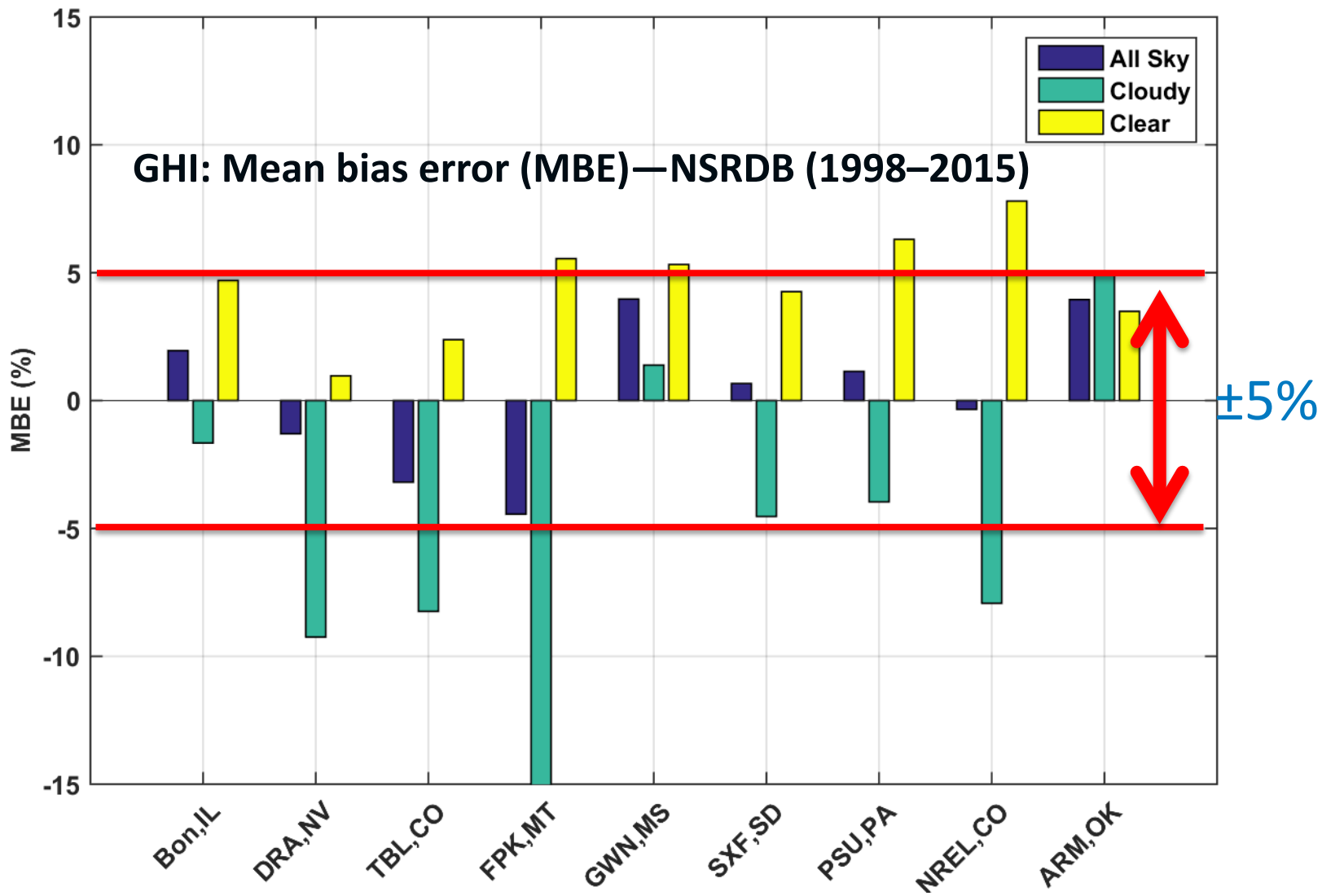


Validation of Satellite Product Using Ground Data

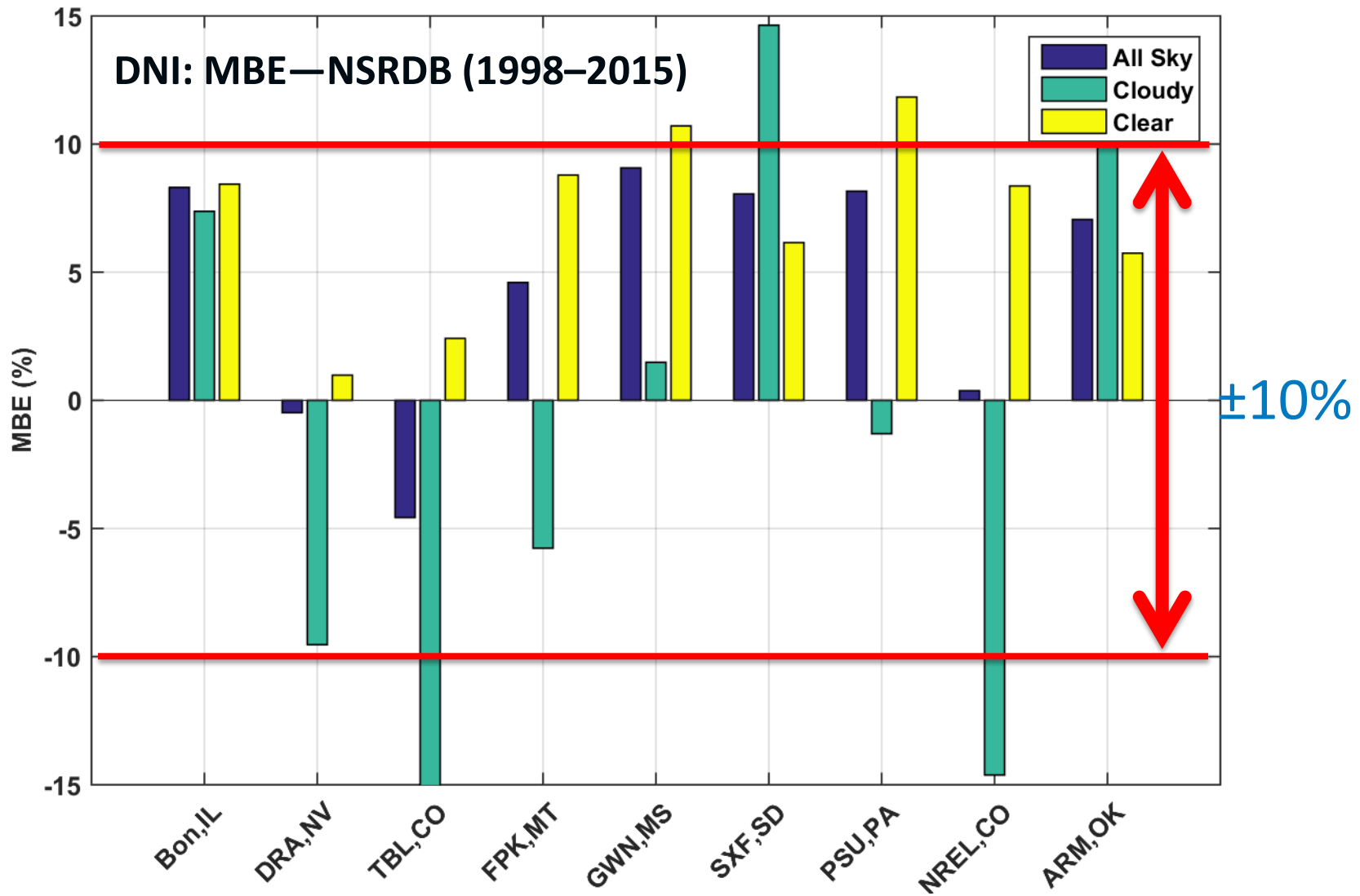
Surface Radiation (SURFRAD) Network, NREL's Solar Radiation Research Laboratory (SRRL), and the Atmospheric Radiation Measurement (ARM) Southern Great Plains locations



Validation with Surface Measurements



Validation with Surface Measurements

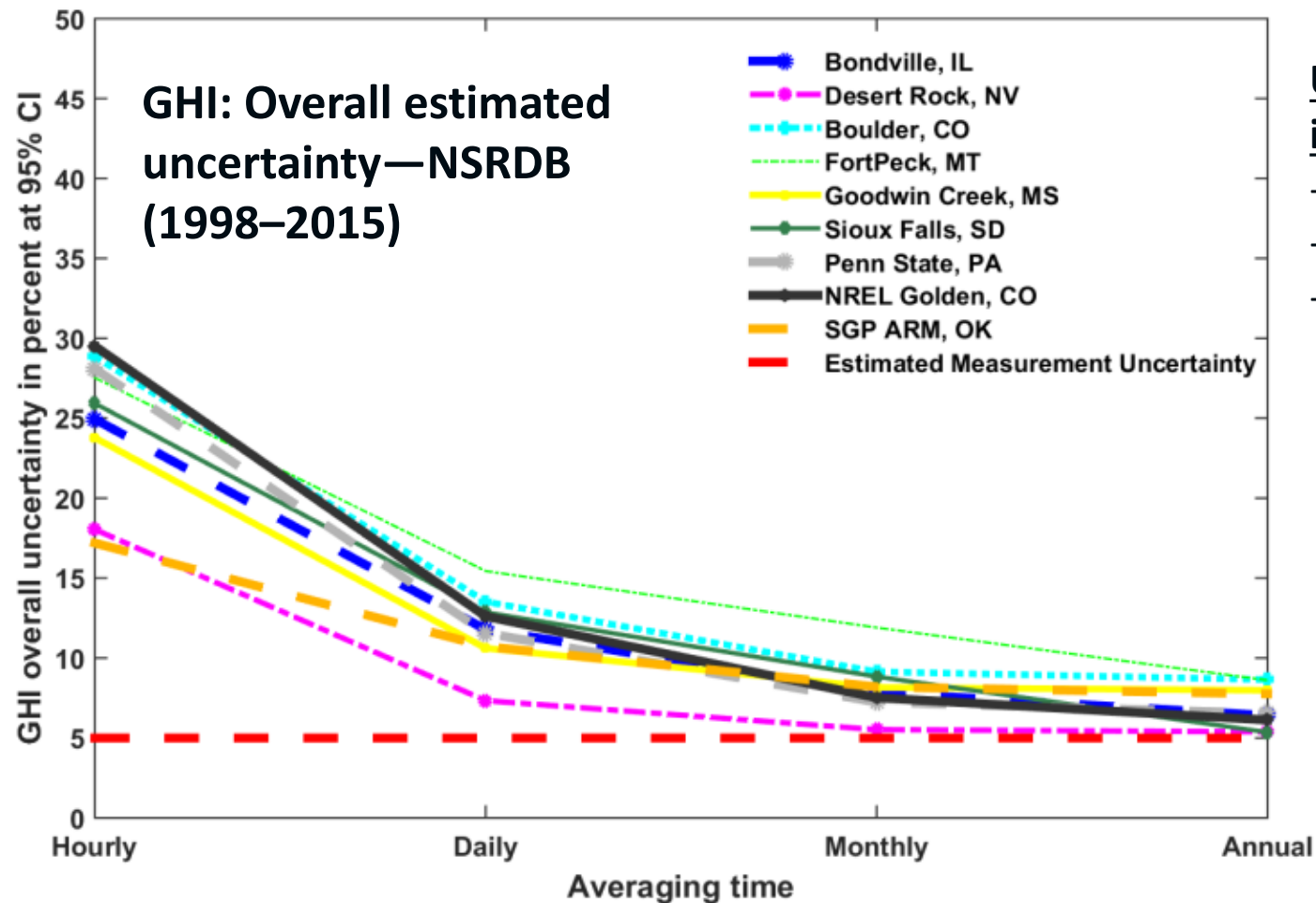


Validation with Surface Measurements

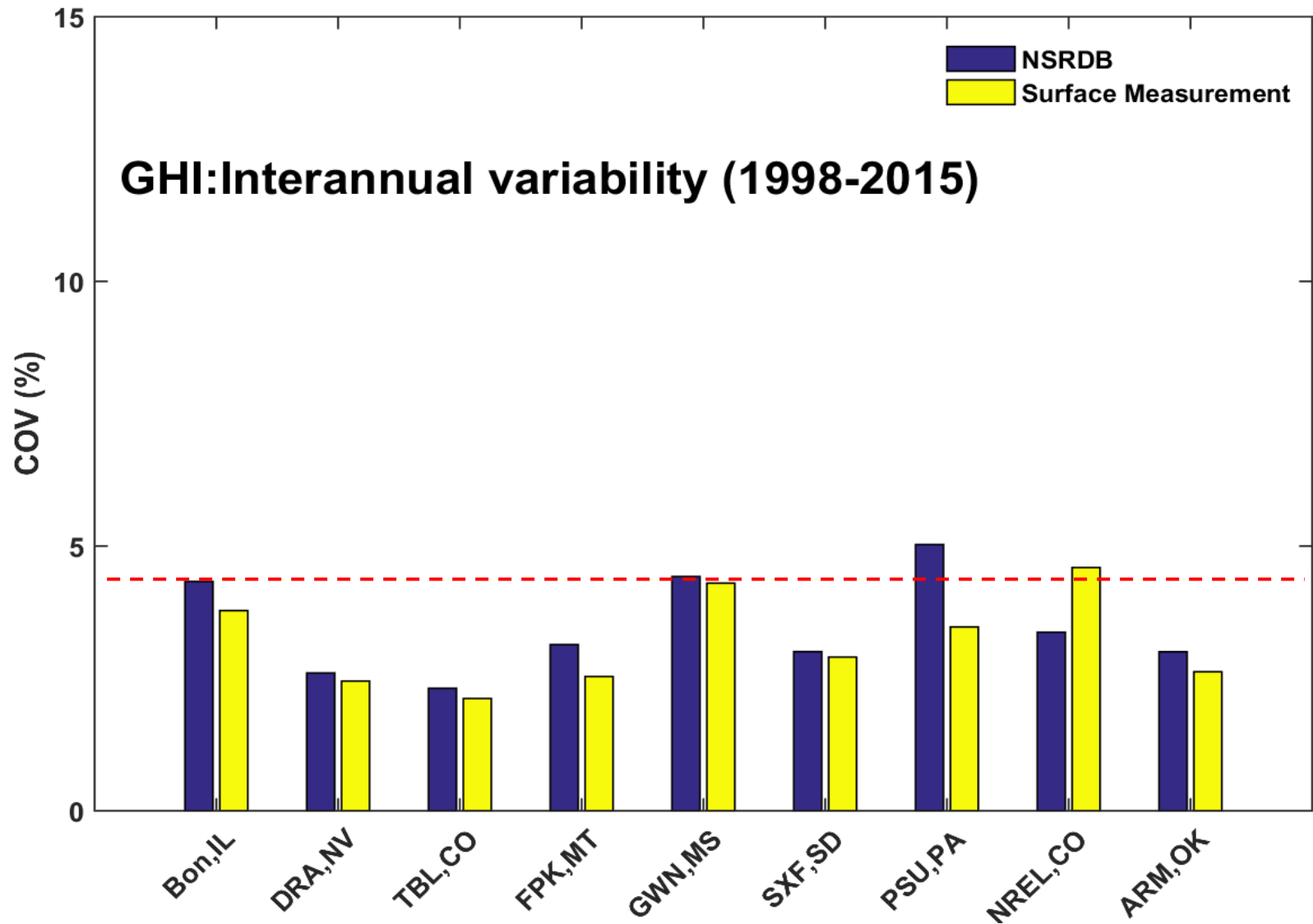
Uncertainty estimation includes:

- MBE
- RMSE
- Surface measurement uncertainty.

GHI: Overall estimated uncertainty—NSRDB (1998–2015)



Interannual Variability for Both NSRDB and Surface Measurements



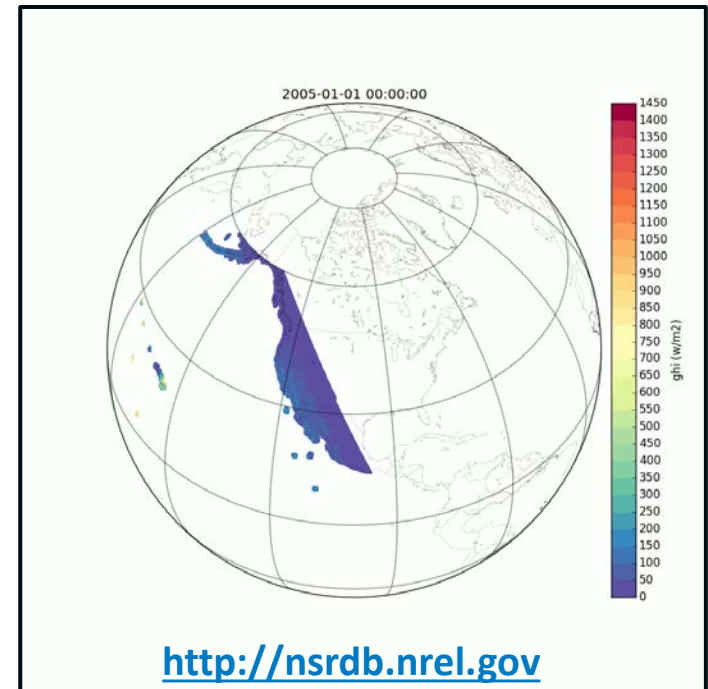
Future Work

Improved inputs:

- Meteorological variables from the National Aeronautics and Space Administration's MERRA2
- Inclusion of hourly or daily MERRA2 aerosols
- Improved surface albedo time series to reflect land use changes
- 5-min. data from GOES-15.

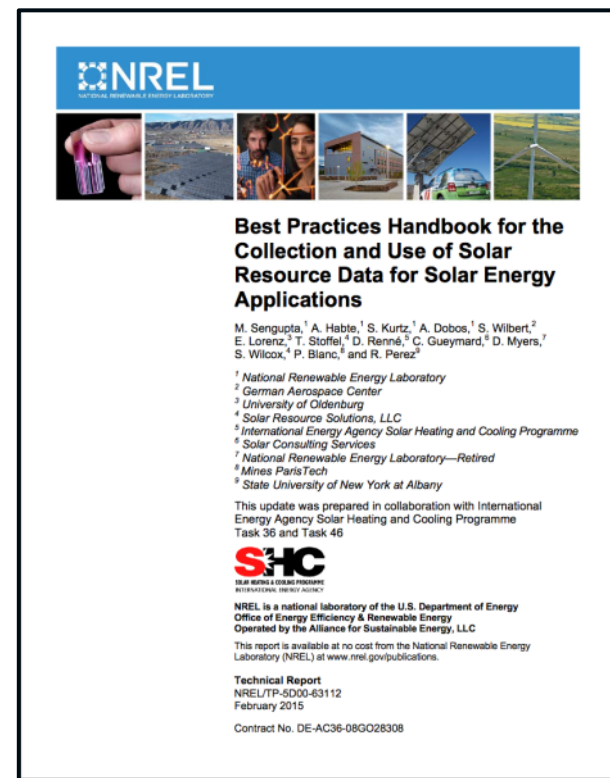
Improved modeling:

- Improved identification of high albedo surfaces (sand and snow)
- Spectral data sets in the plane of array
- Improved cloud retrievals from GOES-15
- Aerosol retrieval from GOES-15.



Using the NSRDB (1998–2015) for Your Application

- New gridded satellite product from 1998–2015 is available publicly from NREL.
- The data set is freely available from <http://nsrdb.nrel.gov>.
- Accurate aerosol and water vapor information is critical to accurately model clear-sky GHI and DNI.
- Significant uncertainty in cloudy cases is mostly from uncertainty due to broken and thin clouds.



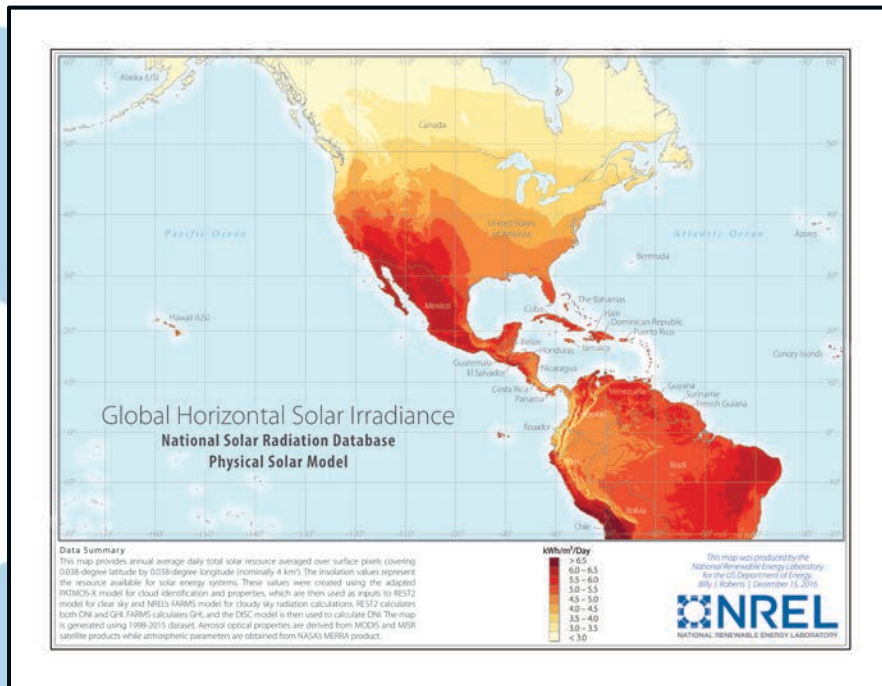
<http://www.nrel.gov/docs/fy15osti/63112.pdf>

Thank You! Contact: manajit@nrel.gov

Our posters:

833: High-Quality Data for Grid Integration Studies—Today

1409: Advances in the Modeling of All-Sky Radiative Transfer for Solar Energy Applications—Tomorrow



www.nrel.gov

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Observations Lead the Way

Observations (or networks) that are needed to benefit your future research, application, or product development:

- Clouds
- Radiation
- Aerosols
- Water vapor
- Surface albedo
- Snow.

Recommended instruments that are needed to make these observations :

- Geostationary satellites (GOES)
- Radiometer network (SURFRAD, ISIS, and more)
- Polar-orbiting satellites (MODIS, MISR)
- Aerosol observations (Aeronet)
- Ground meteorological observations.

Your view on the greatest observational needs for your discipline in general:

- Solar radiation measurement network
- Aerosol measurements.

